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ABSTRACT

The development of the between-class, within-class analysis has facilitated a more refined analysis of classroom processes and influences: those which affect a class as a whole, a student within a class, or an individual student independent of context. However, a problem arises in using a between-class, within-class analysis to infer a particular model of classroom processes. There are several competing classroom process models which can cause any particular pattern of between- and within-class findings. Several examples are given of the correspondence between classroom models and patterns of statistical findings. In one case it is assumed there are no competing effects (zero-order effects). In the other case, competing effects are dealt with. Most of the examples are hypothetical, but real data are given from the Teaching-Learning Interaction Study, where coping style is used to predict achievement gain. In this case, there is a positive within-class, but not between-class effect. The possible causes for this situation are discussed in terms of the models previously given. It is concluded that educational investigators need to use several sources of evidence to infer a particular model, and that any such model needs to be refined and tested. (Author/BW)

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LIMITATIONS OF THE BETWEEN-CLASS, WITHIN-CLASS ANALYSES FOR INDICATING CLASSROOM PROCESSES

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Limitations of the Between-Class, Within-Class Analyses For Indicating Classroom Processes

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Abstract

The development of the between-class, within-class analysis has facilitated a more refined analysis of classroom processes and influences. Specifically, we may now study influences which affect a class as a whole, a student within a class, or an individual student independent of context. However, a problem arises in using a between-class, within-class analysis to infer a particular model of classroom processes.

There are several competing classroom process models which can cause any particular pattern of between- and within-class findings. Several examples are given of the correspondence between classroom models and patterns of statistical findings. In one case it is assumed there are no competing effects (zero-order effects). In the other case, competing effects are dealt with.

Most of the examples are hypothetical, but real data are given from the Teaching-Learning Interaction Study (TLIS), where coping style is used to predict achievement gain. In this case, there is a positive within-class, but not between-class effect. The possible causes for this situation are discussed in terms of the models previously given.

It is concluded that educational investigators need to use several sources of evidence to infer a particular model, and that any such model needs to be subsequently refined and tested, as described by Kuhn in The Structure of Scientific Revolutions.

Limitations of the Between-Class, Within-Class Analyses For Indicating Classroom Processes

The behavior of any one teacher is compounded of many influences and varies complexly as the teacher reacts to different students, to different types of classes, and to different demands of moment-to-moment events. Similarly, the behavior of any one student is a complex product of such different things as his aptitudes, his attitudes toward learning, his self-regard, his concern for peer reactions, his view of a particular teacher, and the feelings engendered by events at home that day. Present levels of data collection and statistical analysis do violence to the true complexity of the classroom, as Cronbach pointed out in 1975. Researchers tend to track isolated variables rather than use a statistical model that represents the dynamic inter-play of many variables at once. Even modern physicists, however, with all their powerful conceptual systems and methodological tools, are not yet able to fully describe the properties of a system with only three interacting bodies.

Educational researchers, nonetheless, are continually upgrading the tools for classroom investigation. Such techniques as profile analysis, canonical correlation, multiple regression, and the like do try to take account of configurations of variables. Still, a predominance of weak and non-replicated results, as well as a burgeoning of theoretical issues, indicates a continuing need for tools that are conceptually, experimentally, and methodologically more sophisticated.

It has become apparent that when one is dealing with large aggregates of data, one must ask whether the individual contexts within which each subject existed needs to be considered (Cronbach and Webb, 1975; Cronbach, Deken and Webb, 1976). In an intensive situation such as the classroom, consideration of the classroom context may very well make the difference between a false model and a reasonably valid one. Cronbach et al., 1976, suggest that in cases where there is reason to believe a context effect exists, the effect should be split into a between-class analysis and a separate within-class analysis. The between-class approach studies the deviation of the mean scores of intact classes of students from the grand mean. It looks at ways in which all or most students, as a class, may be similarly affected by some influence. The within-class approach studies the deviation of individual student scores from the mean of the particular class within which the student operates, thus reflecting the possibility that the same number may be a high score in one class but a low score in another class, with different consequences on some behavioral outcomes.

Cronbach et al. (1975, 1976) and others have given examples, real and hypothetical, of sets of data on which such analyses were performed, with accompanying interrelations. There does not seem to be, however, at present, any well-articulated systematic statement of logical rules for comparing and explaining the possible or probable meanings of the findings from a dual between/within analysis. The present paper is an effort in that direction.

This paper looks at the ways in which patterns of between-class and within-class findings indicate models of reality and, as a very important addition, it illustrates some of the cautions which a researcher must observe when inferring such models. Some hypothetical examples will be given to illustrate the logic of this approach. Some data from the Teaching-Learning Interaction Study will also be presented and interpreted as an empirical example. This work takes up the issues raised by Cronbach, Deken, and Webb (1976). It has parallels in current work by Martin, Veldman and Anderson (1980), and Whitely and Doyle (1979).

Types of Models

We can postulate three different levels of classroom processes: 1) individual or general level; 2) between-class level; and 3) within-class level. At the individual level, the classroom environment makes no difference: the total sample of students are pooled regardless of class, and the assumption is made that a student's initial score will be predictive of his final score, regardless of the class in which he is placed. At the between-class level, the class as a whole is affected, but the variation of the students within-classes is not considered. Finally, at the within-class level, each student is compared, in effect, to the other students in his class, without considering class differences. In other words, what is important is the position of the student with respect to his own class; whether the class itself is high or low is of no concern.

It should be emphasized here that the different levels of analysis assume totally different classroom models. If a general model is used, we are operating under the assumption that classrooms make no difference: one possibility is that classroom differences cannot overcome intrinsic student differences. Another possibility is that all the classes involved are so uniform that differences are not easily detected. Here we start to see the divergence of possibilities which is a necessary consequence of different model assumptions.

A between-class analysis assumes that the class as a whole is affected. A good teacher might, for instance, raise scores of all the students in the class. In other words, it is only the class in which the student sits that is predictive of later scores. Again, there are several competing hypotheses to explain this model: there may be external differences imposed upon classes, such as teacher behavior or there may be differences in class environment due to just the intermingling of certain types of students.

Finally, the within-class analysis implies that the student is affected in relation to the other students in a class. Once again, several possibilities appear. A student may evaluate him or herself in relation to his immediate peers and act accordingly. Or, an external action may be impressed in this case also, as, for example, any systematic tendency of teachers to give more aid to students who are the lowest (or highest) in any given class.

We eventually come to the question of inference: or precisely, what can we infer from our results? There is actually very little which we can prove conclusively. As Kuhn emphasizes in The Structure of Scientific Revolution, the most that we can hope for is that an experimental finding be consistent or inconsistent with a particular paradigm. Still, we have to ask with which model of classroom processes are our findings consistent?

If we are certain of our hypothesized model, there is no problem. We simply choose the appropriate test and perform it. If the test is significant, the model is corroborated; if not, not. We get into somewhat muddier water if we have some data, and wish to use the data to pick the best possible model of classroom processes.

The simplest situation is if we assume that there are no competing effects; that is, we do not have, say, a general process and a within-class process occurring at the same time. We will term this a zero-order situation. In the words of a popular figure, "What you see is what you get." Table 1 gives a summary of the possible patterns of results and their interpretation under the zero-order hypothesis. Generally, if you get a between-class finding, alone, you assume a between-class effect. The conclusion is similar for a within-class effect, alone. If both a within and a between-class effect appear, and if both are in the same direction, it is evidence for a general effect; if the two are in opposite directions, it is evidence for a combination of both within-class and between-class processes.

Table 1

Patterns of Findings and Their Implications Under the Zero-Order Hypothesis

	Between-Class Analysis Significance	Within-Class Analysis Significance	Interpretation
1.	0	0	No class or context effects
2.	+	0	Class effects
3.	0	+	Context effects
4(a).	+	+	Within and between-class effects are in the same direction. Class and context effects cannot be discerned. Interpretation is at the level of the individual pupil.
(b).	-	-	
5.	-	+	Within and between-class effects are in different directions. Both a class and a context effect are assumed.
6.	+	-	

Notes: "+" indicates a positive slope; "-" a negative slope, and "0" means that the effect was not significant.

"Class effect" indicates that being in one class has a different effect on the outcome than being in another class.

"Context effect" indicates a within-class effect such that being above the mean on the predictor, in one's class has a different effect on the outcome than being below the mean on the predictor.

It should be noted that the zero-order assumption is a use of Occam's Razor, which states, roughly, that"all scientific phenomena should be interpreted with the simplest hypothesis available."

We should realize, however, that the zero-order hypothesis is by no means necessarily correct. That is, we may very well have several different processes occurring simultaneously. We term this situation a higher-order assumption. In this situation, the pattern of findings is at most a complex set of clues to an accurate picture of reality. The essence of the situation is that there are several different combinations of processes which could produce any given pattern of statistical results. Table 2 gives a listing of patterns of findings and corresponding models. The primary feature to notice about Table 2 is that for each pattern of statistical results, at least two models of classroom processes are presented. Table 2 uses two variables from the Teaching-Learning Interaction study, coping skill predicting achievement, as an example. The relationships are hypothetical, but the proposed examples serve to illustrate the types of processes which may be inferred.

In Table 2, Model 1 asserts that a general effect, independent of classroom grouping, exists. The general process results in the statistical finding that both the between and within-class tests are significant. Similarly, Model 7 assumes that both a between-class and a within-class process occur, both due to a class-related factor. Again,

Table 2

Correspondence of Classroom Models and Statistical Findings

Model	Finding	Hypothetical Explanations
1. A general effect, based on pregrouping factors, exists.	Both the between-class and within-class analyses are significant.	The coping skills of a student are determinants of the capability of the student to learn material. As a result, students in a class do much better when they have higher coping skills; and classes with high coping skills do better than other classes with lower mean coping skills.
2. A general effect exists, but a between-class effect in the opposite direction also exists.	Only the within-class analysis appears significant.	As in Model 1, the coping skills are an important determinant of learning. However, teachers with lower-coping classes have put extra effort into getting their classes to learn the material; the effort of the teachers acts counter to the mean coping differences between classes.
3. A within-class effect is present, but no betwen or general effects exist.	Only the within-class analysis appears significant.	There is a dynamic within each class affecting the students. The higher copers find the class atmosphere rewarding and are motivated to learn. One of the rewarding aspects is that they get along better than most of the other students.
4. A between-class effect only is present.	Only the between-class analysis appears significant.	The class as a whole is affected by the class coping mean. Higher coping classes present an atmosphere which is more facilitative of learning than lower coping classes. Less talking, disturbances, etc.

Table 2
(Continued)

Correspondence of Classroom Models and Statistical Findings

	Model	Finding	Hypothetical Explanations
5.	A general effect is present, along with a within-class effect in the opposite direction	Only the between-class analysis appears significant.	Coping skills facilitate learning, in general. However, teachers attempt to help students with low coping skills by giving them extra time and help. This multiplies the within-class effects of coping.
6.	A general effect is present, along with within- and between-class effects in the opposite direction from the general effect.	There is no significant finding.	Coping has a general facilitative effect on learning. However, teachers not only push harder for low-coping classes (between-class), but also give extra attention to low-coping students within classes.
7.	No general effect is present; both within- and between-class effects exist.	Both the between-class and within-class analyses are significant.	There is no general effect on coping. However, high coping classes provide a better learning atmosphere. Also, students within classes who find themselves more comfortable than most of the others in a class tend to be more motivated to learn.
8.	No effects occur.	There are no significant findings.	Coping is not related to achievement outcome in any way.

the between- and within-class findings are both significant. Model 1 and Model 7 are indistinguishable with respect to the pattern of statistical results in this analysis.

Similarly, Models 4 and 5 imply a statistical finding that the between-class analysis, but not the within-class, will appear. Model 4 postulates that there is only a between-class effect. Model 5 postulates that both a general and a within-class process exist, but that they are in opposite directions. The within-class process cancels part of the general effect, and only the between-class analysis is significant. Again, we have the situation where two completely different classroom models are indistinguishable, using the statistical test. Model pairs 2 and 3, and 6 and 8 illustrate the same principle.

In the case of the actual data, the achievement scores, controlling for the pretest, are significantly and positively predicted by the coping scores in the within-class analysis ($F[1,1130] = 39.4$, % Variance = 1.3, $p < .001$) but not by the between-class analysis. These data, then, as Table 2 indicates, suggest that either students are reacting to their immediate surroundings (case 3) or else teachers adjust to the general level of classes, thus nullifying inter-class differences (case 2). There is, of course, a whole series of even more complex possibilities which would be described by higher-order models as described above.

Reinforcing a Conclusion

As we have seen, unless we arbitrarily make a restrictive assumption of zero-order processes, any pattern of findings in the within-between class analysis is inconclusive in inferring a classroom process model, even when the data are uncontaminated. So we come once again to a classical question of science: How can we conclude models of reality from our findings?

We believe, with Kuhn, that it is necessary to deal with specified models as our main currency. That is, the researcher must use his or her intuition, past findings, the present pattern of results, and additional data, such as observational reports, to select a plausible model which is subject to confirmation. A combination of different kinds of evidence will be necessary for any valid model of classroom processes to be developed.

Collectively, we who study effects of schooling need to work toward a meta-theory of classroom processes which specifies many different models of cause-effect relationships. No one study, experimental or otherwise, can logically prove that one model is the only true explanation of a particular set of findings. We need to replicate studies much more often. Above all, we need to develop and spell out a set of clear, sensible decision-making rules for interpreting findings from classroom research. Tables 1 and 2 are simply a beginning effort at spelling out alternative interpretive models.

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